#6 12-12-02 Robertson

S/N 09/897,320 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	George Hsieh	Examiner:	Gregory Thompson
Serial No.:	09/897,320	Group Art Unit:	2835
Filed:	June 29, 2001	Docket:	884.462US1
Title:	ELECTRONIC ASSEMBLY WITH SOLDERABLE HEAT SINK AND METHODS OF MANUFACTURE		

DECLARATION UNDER 37 C.F.R. § 1.131

Commissioner for Patents
Washington, D.C. 20231

This declaration is submitted under 37 C.F.R. §1.131 to establish invention of the subject matter of the pending claims prior to December 20, 2000.

I, George Hsieh, do hereby declare:

1. On June 29, 2001, the filing date of the present application designated above, I was an employee of Intel Corporation, the assignee of the present application.
2. I am the sole inventor of all subject matter claimed in the present application.
3. Prior to December 20, 2000, I conceived the inventive subject matter in the United States as evidenced by a copy of a first invention disclosure form attached hereto as "Exhibit A", signed by one of my two supervisors at the time, Scott Dixon. Figures 1-4 on page 6 of "Exhibit A" show a printed circuit board, a heat sink with solderable pins, an electronic device, and a thermal interface material. In addition, Figures 1-4 show wetting of a thermal interface material after the printed circuit board has been passed through a wave-soldering machine. Figures 1-4 further show mounting pins wave-soldered to the printed circuit board after the printed circuit board has been passed through a wave-soldering machine.
4. The dates redacted from "Exhibit A" are prior to December 20, 2000.
5. George R. Anderson is employed by Intel Corporation as a commodity specialist, and he was directed by me, beginning prior to December 20, 2000, to perform various activities related to building embodiments of the inventive subject matter, including procuring various materials and tools, after I conceived the inventive subject matter.

6 "Exhibit B" is a copy of a credit card statement, dated prior to December 20, 2000, of Mr. Anderson, showing the purchase by Mr. Anderson of a Dremel Drill Kit, a Hand Drill, and Drill Bits to be used by Mr. Anderson in building embodiments of the inventive subject matter.

7. "Exhibit C" is a copy of a purchase receipt, dated prior to December 20, 2000, issued to Mr. Anderson, for the purchase of the above-described tools.

8 Prior to December 20, 2000, Mr. Anderson contacted Mr. Bill Walkup of Foxconn, Hillsboro, Oregon, for the purpose of procuring 0.025" square wire for use as mounting pins for prototype heat sinks, and Mr. Anderson received a quantity of 0.025" square wire from Foxconn.

9. "Exhibit D" is a copy of a quotation composed and faxed by Mr. Anderson, prior to December 20, 2000, to Turk Manufacturing, Inc., Hillsboro, Oregon, to obtain price and delivery information for aluminum plates (referred to as "coupons"), to be used in building prototype heat sinks.

10. "Exhibit E" is a copy of another quotation composed and faxed by Mr. Anderson prior to December 20, 2000, to American Precision Industries, Inc., Hillsboro, Oregon, to obtain price and delivery information for aluminum plates (referred to as "coupons"), to be used in building prototype heat sinks.

11. "Exhibit F" is a copy of my credit card statement, showing a payment made to American Precision Industries, Inc., Hillsboro, Oregon prior to December 20, 2000, for fabricating aluminum plates to be used in building prototype heat sinks for use in embodiments of the inventive subject matter.

12. During December 22, 2000 through December 31, 2000, Mr. Anderson built prototype heat sinks by drilling two holes in each aluminum plate received from American Precision Industries, Inc., and by installing 0.025" square wire, received from Foxconn, in each drilled hole to form mounting pins for the prototype heat sinks.

13. During December 22, 2000 through December 31, 2000, Mr. Anderson built the above-mentioned prototype heat sinks while working at home in his garage. In recognition of Mr. Anderson's extraordinary dedication and diligence in building the prototype heat sinks quickly and during his personal time off from work, I awarded Mr. Anderson an Intel "Spontaneous Recognition Award", having received approval from my supervisor to do so.

14. I took vacation time off from my work at Intel from December 23, 2000 through January 1, 2001.

15. During the first week of January, 2001, Mr. Anderson delivered to me completed prototype heat sinks, each having two mounting pins.

16. During the second week of January, 2001, I assembled an electronic assembly using the prototype heat sinks received from Mr. Anderson. The electronic assembly included a printed circuit board on which several integrated circuits were mounted, and at least one heat sink having a pair of pins that were soldered into corresponding holes in the printed circuit board. The heat sink was mounted over one of the integrated circuits, and a thermal interface material was positioned between the integrated circuit and the heat sink.

17. When I completed the electronic assembly, I recognized and appreciated that the completely assembled apparatus, including the heat sinks and thermal interface material, was suitable for its intended purpose of transferring heat from an integrated circuit.

18. "Exhibit G" is a copy of a second invention disclosure form that I completed at least as early as January 18, 2000. Page 8 of "Exhibit G" contains a set of three photographs that are identical to those in "Exhibit H" described below. Paragraph 13 on page 5 of "Exhibit G" states that a "test vehicle used to demonstrate feasibility uses the two-pin thermal plate". The test vehicle is shown in the set of three photographs at the top of page 8 of "Exhibit G".

19. "Exhibit II" is a copy of a PowerPoint slide that includes a set of three photographs. The photographs shown in "Exhibit H" were taken by me during the period of January 8, 2001 to January 17, 2001. I originally created the PowerPoint slide on January 17, 2001, by importing these three photographs. On December 3, 2002, I added the legends appearing on the slide.

20. The three photographs appearing in "Exhibit H" show an electronic assembly, including a printed circuit board, a heat sink mounted over an integrated circuit using pins soldered into holes in the printed circuit board, and a thermal interface material between the integrated circuit and the heat sink. Elements of the claimed subject matter bear the following legends (reading from top to bottom): "heat sink including aluminum plate with two mounting pins soldered-down to a printed circuit board and disposed over an electronic device/heat producing component"; "pink colored thermal interface material/thermal bond (flowing over side of silicon over flip chip package due to heat from wave soldering process)"; "printed circuit board/substrate"; "heat producing component disposed below soldered-down heat sink"; "thermal interface material/thermal bond"; "mounting pin wave soldered into printed circuit board"; and "printed circuit board".

21. The three photographs in "Exhibit H" show heat sink mounting pins wave-soldered to a printed circuit board. In addition, the photographs in "Exhibit H" show successful wetting of thermal interface material after the printed circuit board has passed through pre-heaters of a wave-soldering machine.

22. The photographs shown in "Exhibit II" are the same photographs that I included on page 8 of my second invention disclosure form attached hereto as "Exhibit G".

23. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of this application or any patent issuing thereon.

Date: 12/5/02

George Hatch

Respectfully submitted,

GEORGE HSIEH

By his Representatives,

SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(603) 888-7958

Date 12/6/02 By

Prakash Nama
Reg. No. 44,255

I hereby certify that this paper is being transmitted by facsimile to the U.S. Patent and Trademark Office on the date shown below.

Jane E. Sagers

December 6, 2002
Date of Transmission

EXHIBIT - A

INTEL CONFIDENTIAL
16924 **Attorney-Client Privileged Communication**

TMG INVENTION DISCLOSURE

TMG ATM Comm / TMG ISMTD **Located at:** http://legal.intel.com

LEGAL ID# _____(legal dept. use only) DATE: _____

It is important to provide accurate and detailed information on this form (fill in ALL areas under Inventor[s]). The information will be used to evaluate your invention for possible filing as a patent application. When completed, please return this form to **Janice Boulden, Intel Legal Department at JF3-147. You can submit electronically via e-mail to "Invention disclosure submission" if all of the information is electronic, including drawings and supervisor approval.** If you have any questions regarding this form or to whom it should be forwarded, please call **503-264-0444.**

Fill out the below and follow the instructions:

1. **Field of the Invention:**

- Semiconductor Process: device and integration
- Semiconductor Process + Equipment: thin films
- Semiconductor Process + Equipment: etch/litho
- Circuit Design
- Flash
- Test
- CQN (Q&R)
- Packaging
- ☑ Boards/Cartridge
- Automation
- Other

2. **Concise Title of Invention:**

Using the wave soldering process to attach motherboard chipset heatsinks.

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3. **Brief Description of Invention (please use only space provided and font #10 or larger. Write the Key Elements of the Invention):**

The invention is:

The invention is the use of wave soldering (as opposed to mechanical fasteners or spring clips) as the method for attaching chipset heatsink to motherboards.

The key elements are:

The key elements of this invention are (1) solderable features are formed as a part of the heatsink, (2) heatsink is attached to the motherboard by wave soldering the solderable features into plated through holes on the motherboard, (3) thermal solution uses either a thermal grease or a phase change material that liquefies and wets the device under heat from wave soldering process.

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4. Inventor(s):

Name: George Hsieh
E-Mail Address: george.hsieh@intel.com
WWID# 10564853
M/S: HF1-79
Phone: 503-696-6227
Fax: 503-696-1521
Home Address: 5449 Preakness Terrace Portland, OR 97229

Citizenship: USA
Supervisor Name: Stephen C. Schade
Supervisor Phone: 696-4347
Supervisor M/S: HF1-79
Group Name: TMG
Contractor:
Inventor Signature:
Division Name: ATD___
PTD___ CTM___ CR___
STTD___ CON ___
SMTD__X__TCAD___
Other?_____
YES _____
NO _____

Name:
E-Mail Address:
WWID#
M/S:
Phone:
Fax:
Home Address:

Citizenship:
Supervisor Name:
Supervisor Phone:
Supervisor M/S:
Group Name: TMG
Contractor:
Inventor Signature:
Division Name: ATD___
PTD___ CTM___ CR___
STTD___ CON ___
SMTD____TCAD___
Other?_____
YES _____
NO _____

Name:
E-Mail Address:
WWID#
M/S:
Phone:
Fax:
Home Address:

Citizenship:
Supervisor Name:
Supervisor Phone:
Supervisor M/S:
Group Name: TMG
Contractor:
Inventor Signature:
Division Name: ATD___
PTD___ CTM___ CR ___
STTD_ _ CON ___
SMTD____TCAD___
Other?_____
YES _____
NO _____

(PROVIDE SAME INFORMATION AS ABOVE FOR EACH ADDITIONAL INVENTOR)

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5. **HAVE YOUR SUPERVISOR READ, DATE AND SIGN COMPLETED FORM (use first inventor's supervisor if multiple inventors)**

DATE: ___ **SUPERVISOR NAME:** [signature]

BY THIS SIGNING, I (SUPERVISOR) ACKNOWLEDGE THAT I HAVE READ AND UNDERSTAND THIS DISCLOSURE, AND RECOMMEND THAT THE HONORARIUM BE PAID.

6. **Has subject matter of present disclosure been disclosed or will it be disclosed outside Intel?**
If yes, explain and give date: No. However, potential suppliers for thermal interface material and sinks will be contacted for samples for discovery work.
(Give expected tape out date if applicable):

7. **Has the subject matter of present disclosure been published or will it be published outside of Intel?** No.
If yes, explain and give date:

8. **Has a product using or manufactured using the present disclosure been sold or offered for sale?**
No.
If yes, explain and give date:

9. **Has this invention been conceived, or constructed during accomplishment of a government or third party contract?** No.
If yes, give contract name and number:

10. **Explain the problem being addressed by the invention:**

This invention addresses the problem of:

This invention addresses the continuing need for reducing the cost of heatsink assembly on motherboards. When power of chipset or devices is relatively low, opportunities to sacrifice θ_{cs} for lower total cost can be exploited.

In addition to manufacturing gains, soldered heatsinks have the additional advantage of being able to provide some degree of local motherboard stiffening around the chipset for no additional cost.

11. **Explain current state of the art (i.e, how the problem is solved today):**

Presently the problem described above is solved by:

Presently, chipset thermal solutions are attached by use of rivets, spring clips, wire clips, or other mechanical fasteners. Some uses epoxy to glue the sink to the device. All of these methods require an *additional assembly step, headcount, and line space after* all soldering steps are completed. The total cost of the chipset thermal solution cannot remove the cost associated with an additional post-solder processing step.

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12. **Explain technical advantages of the invention over current state of the art:**

The technical advantage of this invention is:

The advantage of the Invention is that it is expected to be very cost effective. Assembly of a wave solderable heatsink can be integrated easily into any existing motherboard line that uses wave soldering. The cost of headcount and line space traditionally associated with heatsink attach at final assembly can be eliminated. The material cost of the heatsink is expected to be at parity with current solutions, trading the cost of clips or other mechanical fasteners for wave solderable features mounted in the heatsink.

13. **a. Is the invention experimentally verified?** Yes.
b. Is the invention verified with simulation? No.
c. If neither a. or b. above, then you can get a patent on the concept, but please explain the technical basis to justify that your invention will work (use extra space if necessary):

The basis of this Invention is to use heat from the wave preheaters to liquefy thermal interface material during the wave soldering process. As the thermal interface material melts, the weight of the sink deforms the thermal interface material to wet the surface of the active device. Wetting can be assisted by spring-loaded component hold-downs (commonly used in wave soldering to hold tall THM components straight during soldering) for additional compression on the interface heating and soldering. While the thermal interface material is still hot and in the liquid state, the sink is soldered in place over the solder pot. As the board exits the wave, the sink is firmly soldered in place with bondline of the thermal interface material locked in place. The key technical challenge to this invention is producing adequate wetting (assisted only with heat from the wave and the weight of the heatsink) as the thermal interface material melts in the wave preheaters.

The solution used to verify feasibility is done with the enabled thermal solution for the 850 chipset. The enabled thermal solution is a passive pin-fin sink (weighing 18g) attached to an OLGA MCH with wire clips and uses Chomerics T710 phase change thermal interface material. Demonstration was done on a test board with Dixon (same package size as 850 MCH but larger die). Thermal interface material for the demonstration is Chomerics T725, which has no fiberglass mesh carrier whereas T710 does. The pad size was kept the same.

The test board with heatsinks placed on the Dixon devices was passed through the wave using a desktop motherboard wave heating profile. The thermal interface material was allowed to melt and collapse under only the weight of the sink. Once out of the wave, the sink was removed to determine area coverage. The results are shown in section 16.

Since the material thickness and thermal conductivity are the same between Chomerics T710 and T725, thermal performance of the demonstrated solution is expected to be comparable or better than the current mechanically-attached solution. However, since the demonstrated solution uses only the wave for thermal solution, it is expected to be less costly as final assembly is not longer required.

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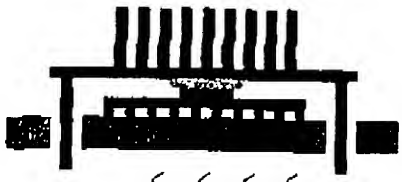
14. **Detailed Description of Invention (<u>try to use only the space provided</u> with font #10 or larger type. Refer to your drawings):**

1.

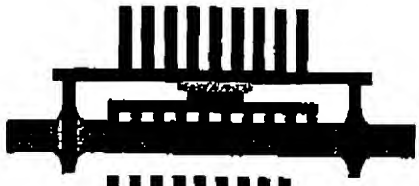
Sink is hand-placed on board along with other THM components. Interface material is either a phase change pad or dispensed grease

2.



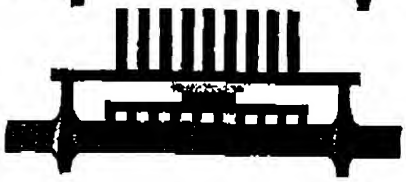
Thermal interface material melts *or becomes less viscous from heat* in wave preheaters. Thermal material wets device and bond line is reduced slightly from weight of the sink.

3.



Sink is soldered in place over the wave solder pot while the thermal interface material is still hot.

4.



Board exits wave and cools. Sink is soldered in place with thermal interface material bond line locked.

<u>Referenced sketches/dwg's/diagrams: (use additional page(s))</u>

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15.

Drawings (use as many pages as needed)
(PLEASE DO NOT MAKE COLOR DRAWINGS)

Figure 1, Present State of the Art (often this is helpful to explain your invention, but it is not required).

Shown below are 4 common methods for attaching thermal solution to motherboard chipset devices. None uses wave soldering as a method for attach, and all requires additional final assembly step (or more in the case with epoxy attach).

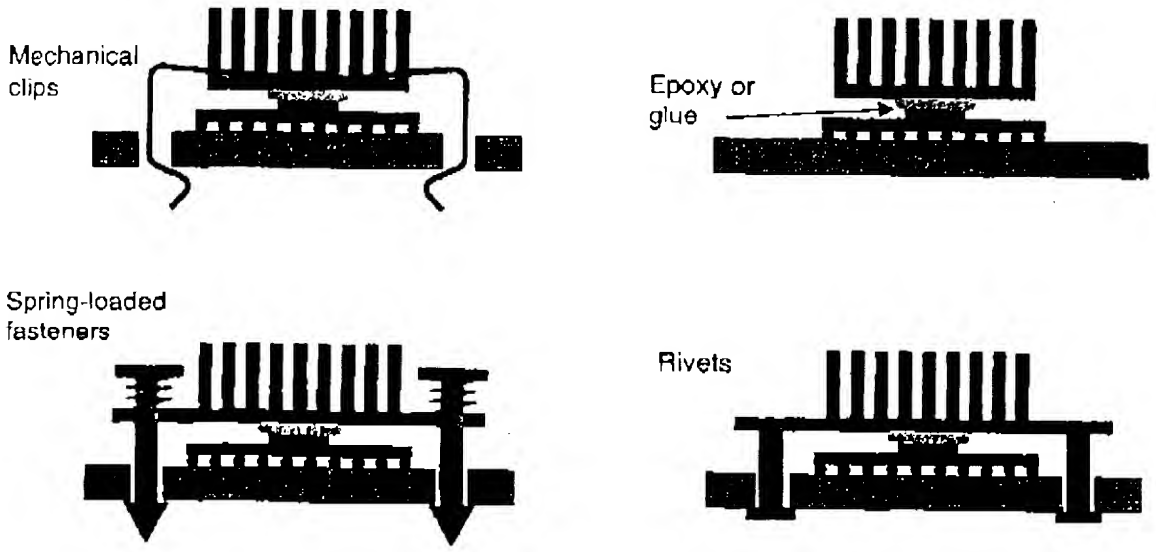

Figure 2. The Invention (use additional figures as needed to show details and additional Embodiments)

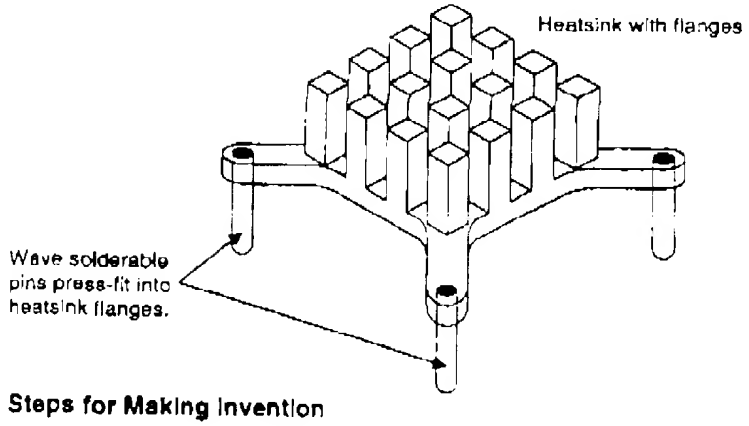

Figure 3,4,5, etc. Steps for Making Invention

Manufacturing of passive sinks with flanges is already HVM processes from suppliers. Addition of solderable features can be accomplished by a press-fit operation after stamping out the sink.

Alternative y, the sink can be cast around the wave solderable pins.

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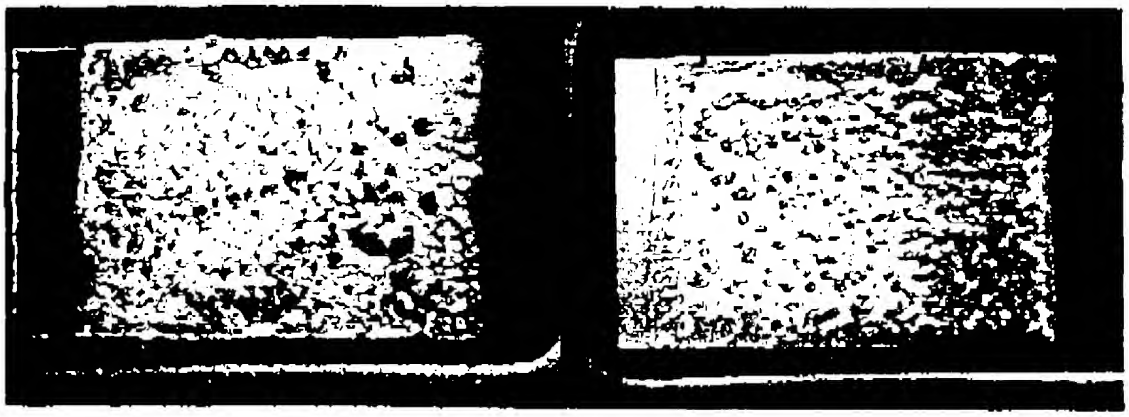
16. **Key Supporting Data (1 page limit on separate page):**

Shown below are two examples of the wetting characteristics of 0.5"x0.5" pad size 0.005" thick Chomerics T725 pad on an OLGA device.

The phase transition temperature of the T725 material is 58°C. The wave profile was that for Garibaldi, the motherboard 850 chipset launch. Measurement shows the temperature of the heatsink surface where the thermal interface material is attached is above 60°C for 30~40 seconds in a typical pass through the wave. Temperature is above 70° for 13~25 seconds and above 80°C for 8~12 seconds. The thermal interface material melts during preheating and wave soldering.

The sink used is an 18g pin-fin heatsink (same as that enabled for the 850 chipset). Wetting was not assisted by use of any component hold-downs or additional weights on the sink.



In both cases, the thermal interface material has completely wet the back of the silicon over the entire 0.5"x0.5" thermal interface pad area (the Dixon silicon in this demonstration was longer than 0.5" in one direction). The lightweight of the heatsink is sufficient to cause adequate wetting to ensure good thermal contact when the material melts in the wave preheaters. Since the T725 material used in this demonstration and T710 material currently used in the 850 chipset thermal solution has the same initial thickness (both 0.005" thickness) and apparent thermal conductivity (both 0.7 W/m·K), the case-to-sink thermal resistance θ_{cs} of the demonstrated solution is expected to be comparable or better than that of the 850 chipset.

17. **What is the product or process invention to be used on? (e.g., P8xx, name of product, etc.):**
Desktop mother boards – wave soldering.

18. **Have you reviewed your invention with a TMG Patent Mentor? (see below for mentor names) If so, give name:** _____

19. **Any other information IP committee should consider?**

EXHIBIT - B

WELLS FARGO

Additional Information Regarding
Account Number: [redacted]
Statement Date: 12/29/00

[redacted]

Transactions

Trans Post	Reference Number	Description	Credits	Charges
	24254777P3QZWNGTLD	THE TOOL PEDDLER PORTLAND OR		29.95
	24254777P3QZWNGTLM	THE TOOL PEDDLER PORTLAND OR		115.49

Bits, Hard Drill
Drill kit

Statement for December 2000
George R Anderson
George R Anderson
11-20-02

EXHIBIT - C

THE TOOL PEDDLER
9907 SE 82ND AVE
PORTLAND, OR. 97266
503-777-8665

COPY

Sale:

Transaction #	29
Card Type:	VISA
Exp. Date:	0703
Entry:	Swiped
Sale:	115.19
Reference No.:	0038 0358
Auth Code:	003694
Response	AP

Drawer Drill + K.T.

Intel Corporation

EXHIBIT - D

intel.

Fax

Page 1 of 2

Urgent:

Confidential

Date:

Subject: Sketch for coupons.

From: George R. Anderson	Phone# : 503-456-1337 Fax # 503-456-1224	M/S: AG4-409
To: Mark Franzen	Fax#: 503-693-0427	M/S:

Turk manufacturing

Message:

Mark,

Page 2 and is the sketch of the coupons that we discussed this afternoon.
Please quote price for or sooner delivery of the following:

Qty of 200 pcs

Mat'l is aluminum, .100 thick X 2 " X 2"
4 Holes will be though .024 to .026 in dia. Will advise correct dia.

Note that the coupon can be longer to 2.2" satisfy the 1.908 center to center hole locations.

Regards
George R. Anderson
Commodity Specialist
Email: george.r.anderson@intel .com
M/S AG4-409
20420 Von Neumann Drive
Beaverton, Oregon 97006

FAXFORM.DOC / REV. 3/93

Intel Corporation

EXHIBIT - E

intel.

Fax

Page 1 of 2

Urgent:

Confidential

Date:

Subject: Sketch for coupons.

From: George R. Anderson Phone# : 503-456-1337 M/S: AG4-409
Fax # 503-456-1224

To: SHAWN Fax#: 503-642-5454 M/S:

American Precision Ind.

Message:
Shawn,

Page 2 and is the sketch of the coupons that we discussed yesterday.
Please quote price for or sooner delivery of the following:

Qty of 200 pcs

Mat'l is aluminum, .100 thick X 2 " X 2"
4 Holes will be though .024 to .026 in dia. Will advise correct dia.

Note that one 2" leg can be longer to 2.2" satisfy the 1.908 center-to-center hole locations.

Regards
George R. Anderson
Commodity Specialist
Email: george.r.anderson@intel .com
M/S AG4-409
20420 Von Neumann Drive
Beaverton, Oregon 97006

EXHIBIT - F

usbank.

Statement

INTEL CORPORATION

U.S. BANK NATIONAL ASSOCIATION ND
C/O U.S. BANCORP SERVICE CENTER, INC.
P.O. BOX 6343
FARGO, ND 58125-6343

ACCOUNT NUMBER [redacted]

REMIT TO:
U.S. BANK NATIONAL ASSOCIATION ND
C/O U.S. BANCORP SERVICE CENTER, INC.
PO BOX 6310
FARGO, ND 58125-6310

PAYMENT DUE ON RECEIPT
$ .00

AMOUNT ENCLOSED
$

N 000093
GEORGE HSIEH
INTEL CORP - SPOCC
5200 NE ELAM YOUNG PKWY
HF1-79
HILLSBORO OR 97124-6463

PLEASE MAKE ANY ADDRESS CHANGES ON THE BACK OF THIS PAYMENT COUPON

[redacted] 000000000

POSTING DATE	DESCRIPTION	TRANS DATE	REFERENCE NUMBER	AMOUNT CR-CREDIT PY-PAYMENT
	********** NOTICE MEMO ITEMS LISTED BELOW **********			$
	J.C.CUSTOM MACHINING HILLSBORO OR		24557171013059088444363 3799	636.50
	0000000000000000 TAX $ 0.00			
	AMERICAN PRECISION IND HILLSBORO OR		24717051018640181916487 5045	98.00
	1111 TAX $ 0.00			
	MC MASTER CARR SUPP 630-834-9600 IL		24110391019004000382409 5085	8.73
	VERBAL GEORGE TAX $ 0.00			
	********** TOTAL AMOUNT OF MEMO ITEM(S):			743.23

CARDHOLDER SIGNATURE MANAGER SIGNATURE

TRANSACTION LOG NOT REQUIRED: SUBMIT PACKET TO SPOCC ADMINISTRATOR EYI-24 BY THE 30TH OF THE MONTH!

ACCOUNT NUMBER [redacted]

SEND BILLING INQUIRIES TO:
U.S. BANK NATIONAL ASSOCIATION ND
C/O U.S. BANCORP SERVICE CENTER, INC.
P.O. BOX 6344
FARGO, ND 58125-6344

CUSTOMER SERVICE PHONE
1-800-344-5696

STATEMENT DATE:
FEB 05,2001

LOST/STOLEN CARDS CALL:
1-800-344-5696

ACCOUNT SUMMARY

PREVIOUS BALANCE	.00
PURCHASES & OTHER CHARGES	.00
CASH ADVANCES	.00
CREDITS	.00
PAYMENTS	.00
LATE PAYMENT CHARGE	.00
CASH ADVANCE FEE	.00
NEW BALANCE	.00

EXHIBIT - G

P 11292
resubmit
#16924

INTEL CONFIDENTIAL
Attorney-Client Privileged Communication
RESUBMISSION
TMG/TM / TMG/SMTD
TMG INVENTION DISCLOSURE
Located at: http://legal.intel.com
884.462051

LEGAL ID# _____(legal dept. use only) DATE: JAN 18 2001

It is important to provide accurate and detailed information on this form (fill in ALL areas under Inventor[s]). The *information will be used to evaluate your invention for possible filing as a patent application. When completed,* please return this form to **Janice Boulden, Intel Legal Department at JF3-147. You can submit electronically via e-mail to "invention disclosure submission" if all of the information is electronic, including drawings and supervisor approval.** If you have any questions regarding this form or to whom it should be forwarded, please call **503-264-0444**.

Fill out the below and follow the instructions:

1. **Field of the Invention:**

- Semiconductor Process: device and integration
- Semiconductor Process + Equipment: thin films
- Semiconductor Process + Equipment: etch/litho
- Circuit Design
- Flash
- Test
- CQN (Q&R)
- Packaging
- ☑ Boards/Cartridge
- Automation
- Other

RECEIVED
JAN 22 2001
PATENT DATABASE GROUP
INTEL LEGAL TEAM

2. **Concise Title of Invention:**

Using the wave soldering process to attach motherboard chipset heatsinks.

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3. **Brief Description of Invention (please use only space provided and font #10 or larger. Write the *Key Elements of the Invention*):**

The invention is:

The invention is the use of wave soldering (as opposed to mechanical fasteners or spring clips) as the method for attaching chipset heatsinks or thermal plates to motherboards.

The key elements are:

The key elements of this invention are (1) solderable features are formed as a part of the heatsink or thermal plate, (2) heatsink is attached to the motherboard by wave soldering the solderable features into plated through holes on the motherboard, (3) thermal solution uses either a thermal grease or a phase change material that liquefies and wets the device under heat from wave soldering process.

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4. Inventor(s):

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Contractor:
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PTD___ CTM___ CR___
STTD___ CQN ___
SMTD__X__TCAD___
Other?_____ ___
YES _____
NO _____

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Supervisor M/S:
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STTD___ CQN ___
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Other?_____
Contractor:
Inventor Signature:
YES _____
NO _____

(PROVIDE SAME INFORMATION AS ABOVE FOR EACH ADDITIONAL INVENTOR)

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5. **HAVE YOUR SUPERVISOR READ, DATE AND SIGN COMPLETED FORM (use first inventor's supervisor if multiple inventors)**

DATE: _____ **SUPERVISOR NAME:** _____

BY THIS SIGNING, I (SUPERVISOR) ACKNOWLEDGE THAT I HAVE READ AND UNDERSTAND THIS DISCLOSURE, AND RECOMMEND THAT THE HONORARIUM BE PAID.

6. **Has subject matter of present disclosure been disclosed or will it be disclosed outside Intel?**
If yes, explain and give date: No. However, potential suppliers for thermal interface material and sinks will be contacted for samples for discovery work.
(Give expected tape out date if applicable):

7. **Has the subject matter of present disclosure been published or will it be published outside of Intel?** No.
If yes, explain and give date:

8. **Has a product using or manufactured using the present disclosure been sold or offered for sale?** No.
If yes, explain and give date:

9. **Has this invention been conceived, or constructed during accomplishment of a government or third party contract?** No.
If yes, give contract name and number:

10. **Explain the problem being addressed by the invention:**

This invention addresses the problem of:

This invention addresses the continuing need for reducing the cost of heatsink assembly on motherboards. When power of chipset or devices is relatively low, opportunities to sacrifice θ_{cs} or θ_{js} for lower total cost can be exploited.

In addition to manufacturing gains, soldered heatsinks have the additional advantage of being able to provide some degree of local motherboard stiffening around the chipset for no additional cost.

11. **Explain current state of the art (i.e, how the problem is solved today):**

Presently the problem described above is solved by:

Presently, chipset thermal solutions are attached by use of rivets, spring clips, wire clips, or other mechanical fasteners. Some uses epoxy to glue the sink to the device. All of these methods require an additional assembly step, headcount, and line space after all soldering steps are completed. The total cost of the chipset thermal solution cannot remove the cost associated with an additional post-solder processing step.

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12. **Explain technical advantages of the invention over current state of the art:**

The technical advantage of this invention is:

The advantage of the invention is that it is expected to be very cost effective. Assembly of a wave solderable heatsink can be integrated easily into any existing motherboard line that uses wave soldering. The cost of headcount and line space traditionally associated with heatsink attach at final assembly can be eliminated. The material cost of the heatsink is expected to be at parity with current solutions, trading the cost of clips or other mechanical fasteners for wave solderable features mounted in the heatsink.

13. a. **Is the invention experimentally verified?** Yes.
    b. **Is the invention verified with simulation?** No.
    c. **If neither a. or b. above, then you can get a patent on the concept, but please explain the technical basis to justify that your invention will work (use extra space if necessary):**

The basis of this invention is to use heat from the wave preheaters to liquefy thermal interface material during the wave soldering process. As the thermal interface material melts, the weight of the sink deforms the thermal interface material to wet the surface of the active device. Wetting can be assisted by spring-loaded component hold-downs (commonly used in wave soldering to hold tall THM components straight during soldering) for additional compression on the interface during heating and soldering. While the thermal interface material is still hot and in the liquid state, the sink is soldered in place over the solder pot. As the board exits the wave, the sink is firmly soldered in place with bondline of the thermal interface material locked in place. The key technical challenge to this invention is producing adequate wetting (assisted only with heat from the wave and the weight of the heatsink) as the thermal interface material melts in the wave preheaters.

The test vehicle used to demonstrate feasibility uses the two-pin thermal plate variant of the design. The pins are 0.025" square cross-section, typical of headers and floppy/hard drive connectors. The thermal plate is constructed to be of the same mass (18g) as the thermal solution used for the 850 chipset MCH. Demonstration was done on a test board with Dixon (same OLGA package size as the 850 MCH but larger die). Thermal interface material used in the demonstration is Chomerics T725 phase change thermal interface material. The pad size applied to the thermal plate is 0.5"x0.5", same as that on the 850 chipset thermal solution. Each thermal plate uses two plated through holes at opposing corners of the OLGA. The holes are 0.038" finished diameter plated through hole, a typical size for many of the motherboards. Compared to the current 850 chipset thermal solution, the use of only two holes represents a 50% reduction in board space consumed to attach a thermal solution.

Test boards with thermal plates placed on the Dixon devices were passed through the wave using the Garibaldi (Willamette/850 launch platform) motherboard wave heating profile. The thermal interface material was allowed to melt and collapse under only the weight of the sink (no assistance with component hold-downs). Once out of the wave, the sink was removed to examine area coverage. The results are shown in section 16.

In addition, the tested thermal plates were successfully reworked. Sixteen soldered thermal plates were de-soldered using only the hand-soldering guns provided at motherboard rework areas. Residual thermal interface material on the die was cleaned off completely by wiping with isopropanol.

Since the material thickness and thermal conductivity are the same between Chomerics T725 and T710, the latter is used in the enabled thermal solution for the 850 chipset MCH, thermal performance of the demonstrated interface is expected to be comparable to the current mechanically-attached solution. However, since the demonstrated solution uses only the wave for thermal solution, it is expected to be less costly as final assembly is not longer required.

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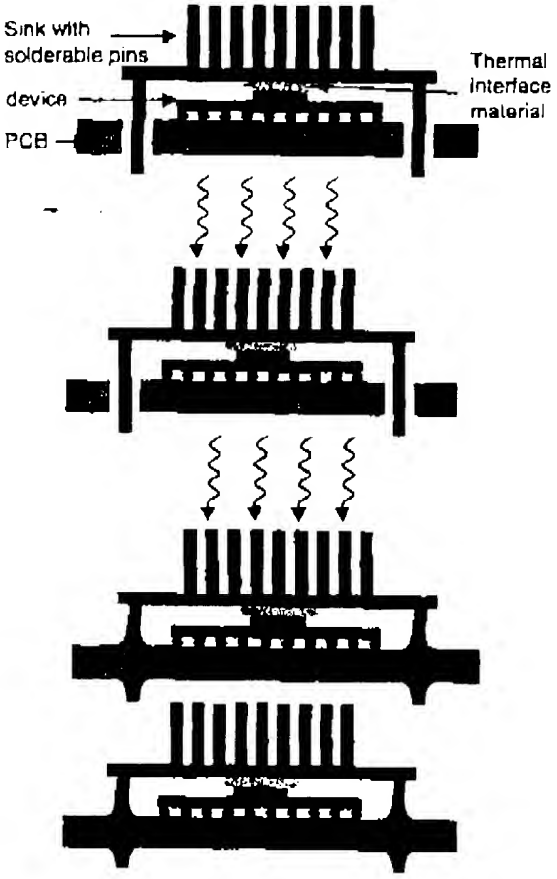
14. **Detailed Description of Invention (try to use only the space provided with font #10 or larger type. *Refer to your drawings*):**



1. Sink is hand-placed on board along with other THM components. Interface material is either a phase *change pad or dispensed grease*

2. Thermal interface material melts or becomes less viscous from heat in wave preheaters. Thermal material wets device and bond line is reduced slightly from weight of the sink.

3. Sink is soldered in place over the wave solder pot while the thermal interface material is still hot.

4. Board exits wave and cools. Sink is soldered in place with thermal interface material bond line locked.

The soldered thermal solution can take the form of either a sink or simply a thermal plate, and it can have either four or two wave solderable features. Minimum requirement is two. A four pin design allows the heatsink or a thermal plate to become a local board stiffening device, which is desirable in certain cases although not a requirement for this invention.

Referenced sketches/dwg's/diagrams: (use additional page(s))

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15.

Drawings (use as many pages as needed)
(PLEASE DO NOT MAKE COLOR DRAWINGS)

Figure 1. Present State of the Art (often this is helpful to explain your invention, but it is not required).

Shown below are 4 common methods for attaching thermal solution to motherboard chipset devices. None uses wave soldering as a method for attach, and all requires additional final assembly step (or more in the case with epoxy attach).

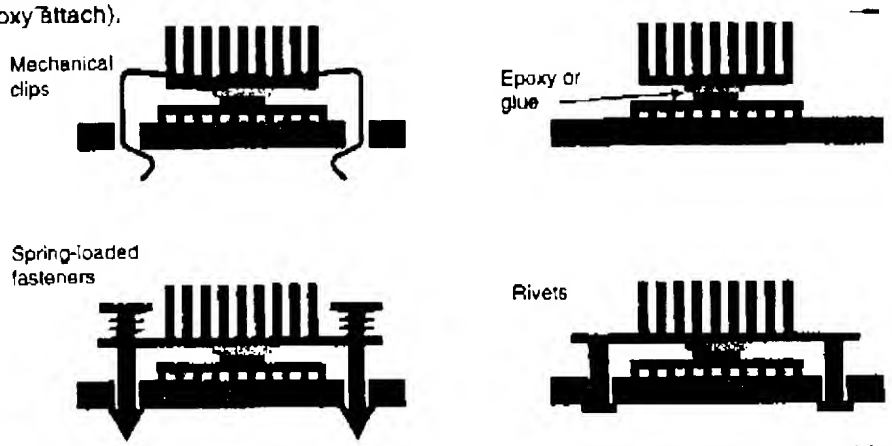

Figure 2. **The Invention (use additional figures as needed to show details and additional Embodiments)**

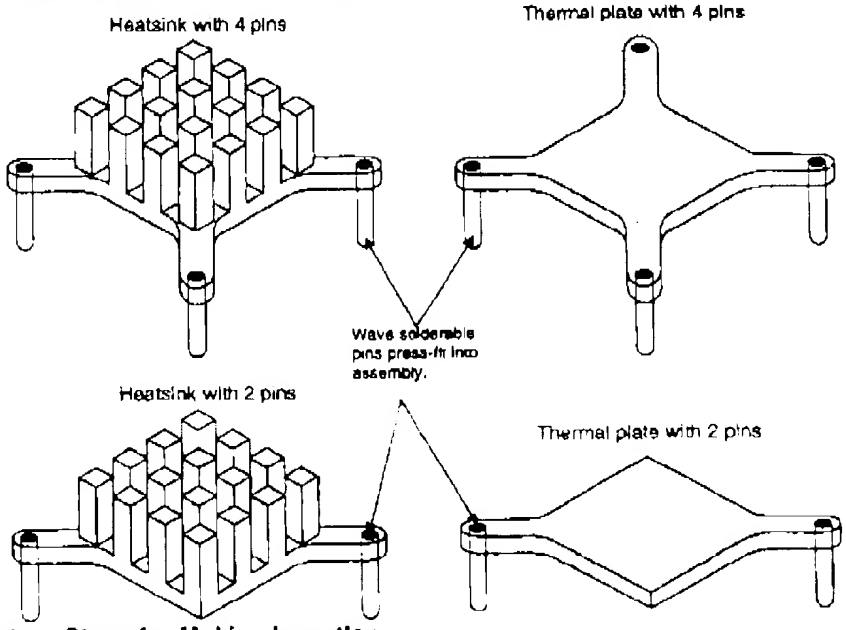

Figure 3,4,5, etc. Steps for Making Invention

Manufacturing of passive sinks with flanges is already an HVM processes from suppliers. Addition of solderable features can be accomplished by a either a punch or drill & press-fit insertion operation after stamping out the sink.

Alternatively, the sink can be cast around the wave solderable pins.

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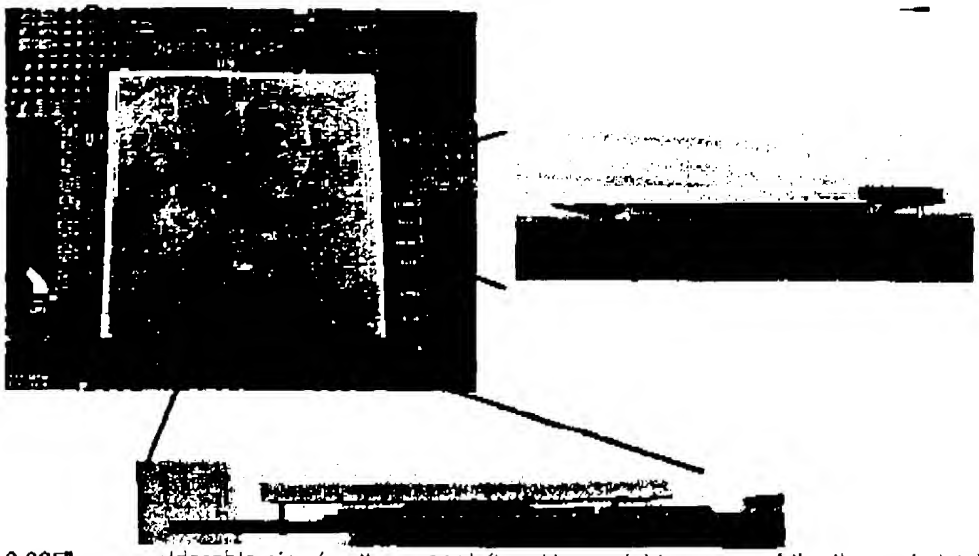
16. Key Supporting Data (1 page limit on separate page):

Shown is the two pin thermal plate assembled according to the design outlined in this disclosure. The wetting of 0.5"x0.5" pad size 0.005" thick Chomerics T725 pad on an OLGA device is also shown.

The phase transition temperature of the T725 material is 58°C. Measurement of the Garibaldi wave soldering temperature profile shows the temperature of the heatsink surface where the thermal interface material is attached stays above 60°C for 30~40 seconds in a typical pass through the wave. Temperature is above 70° for 13~25 seconds and above 80°C for 8~12 seconds. The thermal interface material melts during preheating and wave soldering.



The two 0.025" wave solderable pins (on the upper left and lower right corners of the thermal plate) is soldered into two 0.038" finished plated through holes on the PCB. Two pins are sufficient to fasten the thermal plate onto the PCB. Clearly seen beneath the thermal plate is the OLGA. Thermal interface material can be seen at the edge of the die.

Thermal material coverage thermal plate side

Thermal material coverage die side

The thermal interface material has completely wet the back of the silicon, well beyond the 0.5"x0.5" outline of the onginal pad. The lightweight of the thermal plate is sufficient to cause adequate wetting to ensure good thermal contact when the material melts. Since the T725 material used in this demonstration and T710 material currently used in the 850 chipset thermal solution has the same initial thickness (both 0.005" thickness) and apparent thermal conductivity (both 0.7 W/m·K), the case-to-sink thermal resistance θ_{CS} of the demonstrated solution is expected to be comparable to that of the 850 chipset.

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17. **What is the product or process invention to be used on? (e.g., P8xx, name of product, etc.):**
Desktop mother boards – wave soldering.

18. **Have you reviewed your invention with a TMG Patent Mentor? (see below for mentor names) If so, give name:** _____

19. **Any other information IP committee should consider?**

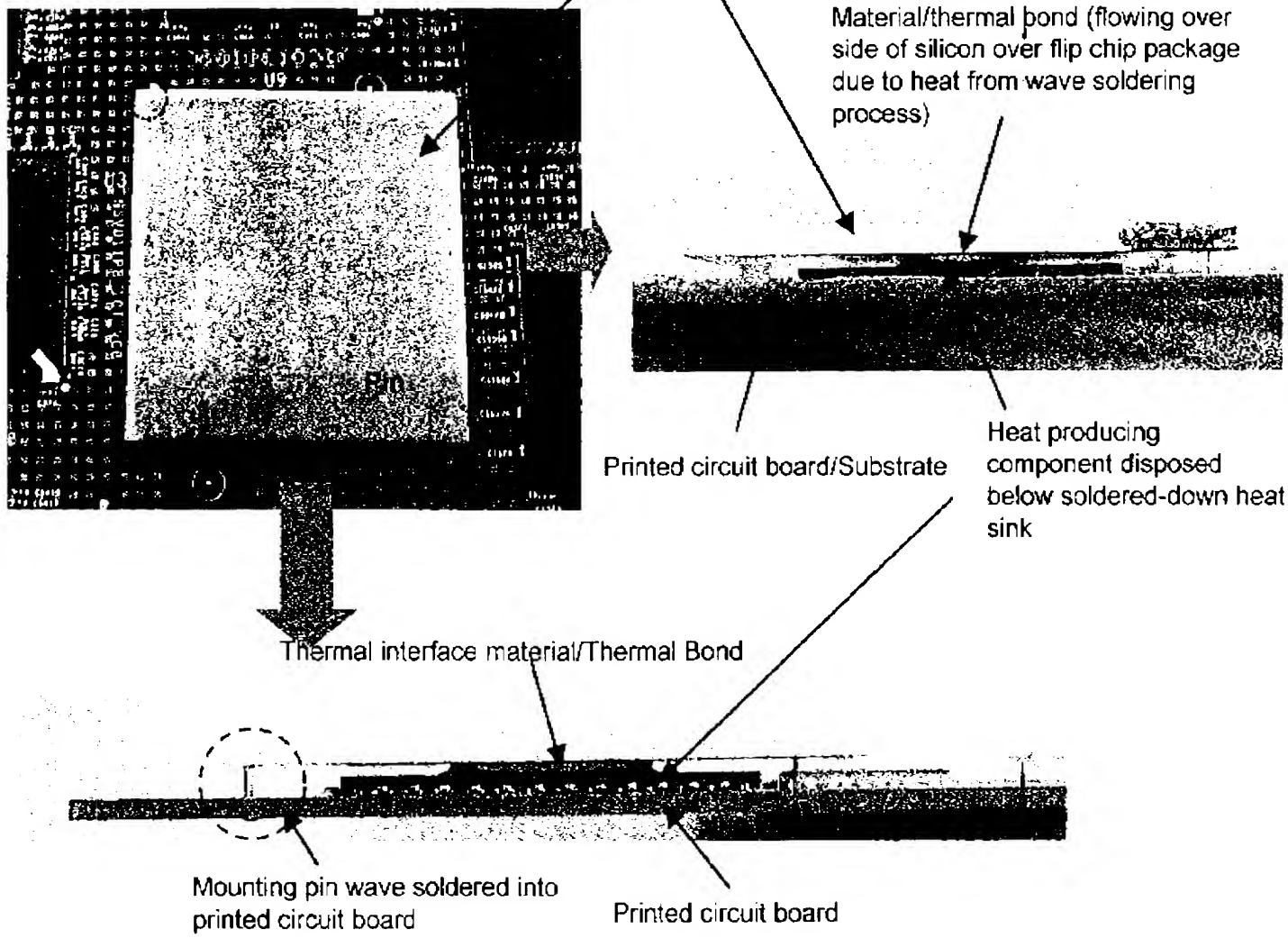

EXHIBIT - H